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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. |
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| 08/801,812      | 02/14/97    | GIVENS               | J 11675.106         |

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EXAMINER

EATON, K

ART UNIT

PAPER NUMBER

2823

DATE MAILED: 07/05/00

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

# Office Action Summary

Application No.

08/801,812

Applicant(s)

GIVENS, JOHN H.

Examiner

Kurt M. Eaton

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).

## Status

- 1) ☒ Responsive to communication(s) filed on 23 May 2000.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-28 and 36-63 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-28 and 36-63 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claims \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are objected to by the Examiner.
- 11) ☐ The proposed drawing correction filed on \_\_\_\_\_ is: a) ☐ approved b) ☐ disapproved.
- 12) ☐ The oath or declaration is objected to by the Examiner.

## Priority under 35 U.S.C. § 119

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).
- a) ☐ All b) ☐ Some \* c) ☐ None of the CERTIFIED copies of the priority documents have been:
1. ☐ received.
2. ☐ received in Application No. (Series Code / Serial Number) \_\_\_\_\_.
3. ☐ received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- \* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. & 119(e).

## Attachment(s)

- 15) ☒ Notice of References Cited (PTO-892)
- 16) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 17) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_.
- 18) ☐ Interview Summary (PTO-413) Paper No(s). \_\_\_\_\_.
- 19) ☐ Notice of Informal Patent Application (PTO-152)
- 20) ☐ Other: \_\_\_\_\_.

## DETAILED ACTION

### *Continued Prosecution Application*

1. The request filed on 5/23/00 for a Continued Prosecution Application (CPA) under 37 CFR 1.53(d) based on parent Application No. 08/801,812 is acceptable and a CPA has been established.

An action on the CPA follows.

### *Claim Rejections - 35 USC § 102*

2. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

3. Claim 54 is rejected under 35 U.S.C. 102(e) as being anticipated by Lee et al..

In re claim 54, Lee et al. (herein referred to as Lee) shows in Figures 4-7 a method for manufacturing an interconnect structure, wherein the method includes forming a lower substrate (16) situated on a semiconductor substrate assembly, the lower substrate defining a plane; forming a dielectric material (30) on the lower substrate having a top planar surface; forming a recess within the dielectric material, wherein the recess includes a contact hole (32) situated below a trench (34), wherein the contact hole terminates at an opposite end thereof at the trench, wherein the contact hole is oriented substantially perpendicular to the plane of the lower substrate, wherein the trench extends from the opposite end of the contact hole to a top surface of the dielectric material, wherein the trench extends substantially parallel to the plane of the lower substrate; and forming an

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electrically conductive layer situated within and filling both the contact hole and the trench and extending to terminate above the planar top surface of the dielectric material {column 6, line 19 – column 7, line 47}.

*Claim Rejections - 35 USC § 103*

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims 1-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Madokoro in view of Fiordalice '072, as previously applied in the office action mailed 5/26/99.

6. Claims 12, 13, 15-20, 22, and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Madokoro in view of Fiordalice '072 as applied to claim 1 above, and further in view of Fiordalice '523, as previously applied in the office action mailed 5/26/99 and Huang et al..

It further would have been obvious to one of ordinary skill in the art at the time the invention was made to form the recess of Madokoro in view of Fiordalice '072 such that it had a contact hole situated below a trench wherein the semiconductor substrate assembly having a lower substrate and terminating at an opposite end thereof at the trench, wherein the trench extends from the opposite end of the contact hole to a top surface of the dielectric material as in Fiordalice '523 since, as suggested by Huang et al. (herein referred to as Huang), the patterning and etching method incorporated by Madokoro to form the interconnects leads to defects, which even if cosmetic, impose serious disadvantages such as the formation of residual metal shorts which lead to

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inconsistent manufacturability, low yields, uncertain reliability, and poor ultra large scale integration extendibility. As taught by Huang, these defects are avoided by forming interconnects using methods similar to the method of Fiordalice '523.

7. Claims 24-28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Madokoro in view of Fiordalice '072, Fiordalice '523, and Huang as applied to claim 16 above, and further in view of Sirkin, as previously applied in the office action mailed 5/26/99.

8. Claims 36-41 and 43-45 are rejected under 35 U.S.C. 103(a) as being unpatentable over Madokoro in view of Fiordalice '072, as previously applied in the office action mailed 11/26/99.

9. Claim 42 is rejected under 35 U.S.C. 103(a) as being unpatentable over Madokoro in view of Fiordalice '072 as applied to claim 36 above, and further in view of Wada et al..

Madokoro in view of Fiordalice '072 substantially discloses the invention as claimed but fails to show wherein the energy absorbing layer is composed out of a material selected from a group consisting of WN, SiN, SiO<sub>2</sub>, Ta, TaN, and C.

Wada et al. (herein referred to as Wada) teaches, in an analogous art related to a method for making aluminum interconnections on insulators, TiN and C are well known equivalents for use as anti-reflection films that act as energy absorbing layers {column 19, lines 36-40}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the energy absorbing layer of Madokoro in view of Fiordalice '072 using C instead of TiN since, as suggested by Wada, C is a material well known within the art that can act as an energy absorbing layer and the selection of a known material on the basis of its suitability for the intended use involves only routine skill in the art.

10. Claims 14 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Madokoro in view of Fiordalice '072 as applied to claim 1 above, and over Madokoro in view of Fiordalice '072,

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Fiordalice '523, and Huang as applied to claim 16 above, respectively, and further in view of Kataoka, as previously applied in the office action mailed 5/26/99.

Furthermore, the specification contains no disclosure of either the critical nature of the claimed aspect ratio of the recess or any unexpected results arising therefrom. Where patentability is said to be based upon particular chosen aspect ratio dimensions or upon another variable recited in a claim, the applicant must show that the particular aspect ratio dimensions are critical.

11. Claims 57, 58, and 60 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schacham-Diamand et al. in view of Lee.

Schacham-Diamand et al. (herein referred to as Schacham-Diamand) shows, in an analogous art related to semiconductor manufacturing, in Figures 15-19 forming an interconnect structure by forming a metal layer (11) situated on a semiconductor substrate assembly, wherein the lower substrate defines a plane; forming a dielectric material (12a) on the metal layer having a planar top surface; forming a recess within the dielectric material, wherein the recess includes a contact hole (15) situated below a trench (25), wherein the contact hole terminates at an opposite end thereof of the trench, wherein the contact hole is oriented substantially perpendicular to the plane of the metal layer and the plane of the substrate, wherein the trench extends from the opposite end of the contact hole to a top surface of the dielectric material, wherein the trench extends substantially parallel to the plane of the metal layer and the plane of the substrate; forming a diffusion layer (17b) on the trench and the contact hole, wherein the diffusion barrier layer is composed of TiN material; forming a seed layer (18b) on the diffusion layer, wherein the diffusion layer is composed of a material that has a melting point greater than or equal to that of the material from which the seed layer is composed; and forming an electrically conductive layer composed of Cu material on the seed layer and extending to terminate at a planar surface of the dielectric material, wherein the material

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from which the diffusion barrier layer is composed has a melting point greater than that of the material from which the electrically conductive layer is composed, wherein the material from which the seed layer is composed has a melting point greater than or equal to that of the material from which the electrically conductive layer is composed {column 6, line 45 – column 9, line 38}.

Schacham-Diamand does not show wherein the interconnect structure is situated on a lower substrate.

Lee shows in Figure 7 forming an interconnect structure on a lower substrate.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the interconnect structure of Schacham-Diamand on a lower substrate as in Lee because it is an intended use of the interconnect structure to provide electrical contact between the interconnect and the substrate.

12. Claims 59 and 62 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schacham-Diamand in view of Lee as applied to claim 57 above, and further in view of Gelatos et al..

Schacham-Diamand in view of Lee substantially discloses the invention as claimed but fails to show wherein the seed layer is composed of titanium.

Gelatos et al. (herein referred to as Gelatos) shows, in an analogous art related to a method for fabricating a metallization structure in a semiconductor device, in Figure 3 that it is well known to form an interconnect structure includes a stack of a TiN diffusion barrier layer (18), a Ti seed layer (20), and an electrically conductive layer composed of Cu material (24), wherein the Ti material from which the seed layer is composed has a melting point greater than that of the Cu material from which the electrically conductive layer is composed {column 3, line 39 – column 4, line 3; column 6, lines 31-35}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the seed layer of Schacham-Diamand in view of Lee such that it was composed of Ti as in Gelatos since a Ti seed layer provides good adhesion to copper.

13. Claims 46-50, 52-56, and 61 are rejected under 35 U.S.C. 103(a) as being unpatentable over Schacham-Diamand in view of Lee as applied to claims 57 and 58 above, and further in view of Zheng et al..

In re claims 48 and 55, Schacham-Diamand further shows in Figure 19 wherein dielectric layer (45) made of silicon nitride {column 10, lines 12 and 13} is formed on the electrically conductive layer (33).

Since layer (45) made out of silicon nitride has a higher thermal insulation capacity and electric insulation capacity than that of the copper material from which the electrically conductive layer is composed of, then layer (45) made of silicon nitride would have to be considered as an energy absorbing layer as claimed.

Schacham-Diamand in view of Lee substantially discloses the invention as claimed but fails to show wherein the contact hole has an aspect ratio greater than 4:1.

Zheng shows, in an analogous art related to a method of making a dual damascene structure, in Figure 2 forming an insulating layer (21) having a thickness between 0.6 – 1.5 microns, a trench (22) 0.4 – 0.8 microns deeps and a contact hole (23) having a diameter between 0.18 – 1 microns. If one of ordinary skill in the art were to arbitrarily select 0.4 as the depth of the trench, 1.1 microns for a height of the contact hole, and 0.18 microns for a diameter of the contact hole, then the contact hole of Zheng would have an aspect ratio greater than 4:1 {column 3, lines 1-15}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the contact hole of Schacham-Diamand in view of Lee such that it had an aspect ratio



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greater than 4:1 as in Zheng since discovering the optimum or workable ranges involves only routine skill in the art.

14. Claim 63 is rejected under 35 U.S.C. 103(a) as being unpatentable over Schacham-Diamand in view of Lee and Gelatos as applied to claim 62 above, and further in view of Zheng.

Schacham-Diamand in view of Lee and Gelatos substantially discloses the invention as claimed but fails to show wherein the contact hole has an aspect ratio greater than 4:1.

Zheng shows in Figure 2 forming an insulating layer (21) having a thickness between 0.6 – 1.5 microns, a trench (22) 0.4 – 0.8 microns deeps and a contact hole (23) having a diameter between 0.18 – 1 microns. If one of ordinary skill in the art were to arbitrarily select 0.4 as the depth of the trench, 1.1 microns for a height of the contact hole, and 0.18 microns for a diameter of the contact hole, then the contact hole of Zheng would have an aspect ratio greater than 4:1 {column 3, lines 1-15}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the contact hole of Schacham-Diamand in view of Lee such that it had an aspect ratio greater than 4:1 as in Zheng since discovering the optimum or workable ranges involves only routine skill in the art.

15. Claim 51 is rejected under 35 U.S.C. 103(a) as being unpatentable over Schacham-Diamand in view of Lee and Zheng as applied to claim 46 above, and further in view of Gelatos.

Schacham-Diamand in view of Lee and Zheng substantially discloses the invention as claimed but fails to show wherein the seed layer is composed of titanium.

Gelatos et al. (herein referred to as Gelatos) shows, in an analogous art related to a method for fabricating a metallization structure in a semiconductor device, in Figure 3 that it is well known to form an interconnect structure includes a stack of a TiN diffusion barrier layer (18), a Ti seed

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layer (20), and an electrically conductive layer composed of Cu material (24), wherein the Ti material from which the seed layer is composed has a melting point greater than that of the Cu material from which the electrically conductive layer is composed {column 3, line 39 – column 4, line 3; column 6, lines 31-35}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the seed layer of Schacham-Diamand in view of Lee and Zheng such that it was composed of Ti as in Gelatos since a Ti seed layer provides good adhesion to copper.

### *Conclusion*

16. Paper related to this application may be submitted directly to Art Unit 2823 by facsimile transmission. Papers should be faxed to Art Unit 2823 via the Art Unit 2823 Fax Center located in Crystal Plaza 4, room 4C23. The faxing of such papers must conform with the notice published in the Official Gazette, 1096 OG 30 (15 November 1989). The Art Unit 2823 Fax Center number is (703) 308-7722 or -7724. The Art Unit 2823 Fax Center is to be used only for papers related to Art Unit 2823 applications.

Any inquiry concerning this communication of earlier communication from the examiner should be directed to **Kurt Eaton** at (703) 305-0383 and between the hours of 8:00 AM to 4:00 PM (Eastern Standard Time) Monday through Friday or by e-mail via [kurt.eaton@uspto.gov](mailto:kurt.eaton@uspto.gov).



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